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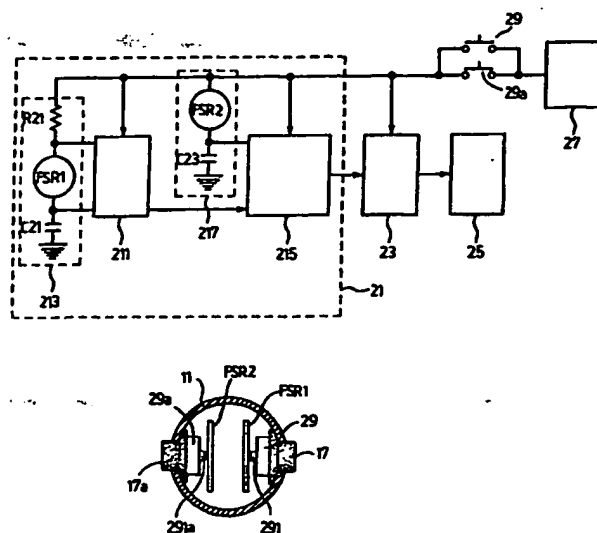
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(54) Title: ARTIFICIAL LARYNX DEVICE



(57) Abstract

Disclosed is a neck type electronic artificial larynx device (10) for enabling a laryngectomized patient, who loses laryngeal functions due to removal of the larynx, to speak. The invention provides a neck type electronic artificial larynx device including an oscillating signal output unit (21) having a frequency oscillator (211) and a pulse oscillator respectively provided with time constant circuits (213, 217) each serving as modulation means and having a time constant variable depending on a variation in resistance, each of said modulation means including a depressing means, and a pressure sensor (FSR) consisting of a resistor element varying in resistance by a depressing operation of said depressing means. In addition, the depressing means is combined with a power switch (29, 29a).

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ARTIFICIAL LARYNX DEVICE

Technical Field

The present invention relates to an artificial larynx device for enabling a laryngectomized patient, who loses
5 laryngeal functions due to removal of the larynx, to speak, and more particularly to an electronic artificial larynx device.

Background Art

Recently, the number of persons who have undergone a
10 laryngectomy due to cancer or other conditions has greatly increased.

The larynx is arranged between the upper and lower portion of the respiratory system. The larynx is a vocal organ in which its vocal cords are vibrated by a breathing
15 air flow. As a breathing air flow passes forcibly through the glottal, it vibrates the vocal cords.

Voice tones or sounds produced by the larynx are vowel sounds. Consonantal sounds are produced by the assistance of the palate, lips, tongue and teeth.

20 The pitch of vocal tone varies in accordance with the frequency of vibrations generated at the vocal cords. A higher pitch of vocal tone is produced when the vocal cords is more tensed and shortened.

Patients having undergone a laryngectomy cannot speak
25 with a high loudness because they have no vocal cords. Such a laryngectomized patient can articulate only consonantal sounds, which are voiceless sounds, by the palate, lips, tongue and teeth. Furthermore, such an articulation of consonantal sounds is very difficult for
30 laryngectomized patients.

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For this reason, to understand the speech of a laryngectomized patient is difficult for others. They should attempt to understand the speech of the laryngectomized patient by observing the lips of the speaker.

Although a laryngectomized patient can somewhat articulate speech after articulation training for a considerable period of time, only persons familiar to his speech can understand the speech. Persons who are not familiar with the speech of the patient cannot understand the speech.

The speech sound of a normal person is produced by virtue of vibrations of the vocal cords and by the assistance of the lips, palate, teeth, and tongue, and then outwardly emitted from the oral cavity.

Basic vibrations of the vocal cords are varied in frequency to produce vocal tones with various pitches. For speaking, laryngectomized patients should use a substitute for the larynx.

As a substitute for the larynx, a laryngectomized patient may produce a sound through the esophagus itself. Otherwise, he uses an artificial larynx.

Some patients having undergone a laryngectomy learn an articulation of esophageal sounds to articulate those esophageal sounds into simple words.

Esophageal sounds are produced by the mucosal plica of the esophagus at the aditus of the esophagus. The mucosal plica of the esophagus serves as a larynx and vibrates as air passes therethrough, thereby producing a deep and husky esophageal sound.

In order to produce esophageal sounds, laryngectomy patients should swallow into the stomach a certain amount

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of air required to produce esophageal sounds in a state in which the tongue is pulled back, and then belch the air from the stomach by a muscle contraction of the stomach.

That is, an esophageal sound is produced as the
5 mucosal plica of the esophagus is vibrated by air belched from the esophagus. Accordingly, it is necessary to swallow air into in an amount as much as possible.

Even persons, who have no experience in producing esophageal sounds, can produce a sound like a belch by
10 quickly swallowing air into the stomach several times until the swallowed air fills the esophagus, and then belching the air all at once from the esophagus.

For the first time, only the sound of a belch is produced. After repeated training, it is possible to
15 produce a sound similar to that produced by the vocal cords.

However, only about 30% of patients having undergone partial laryngectomy have an ability to produce esophageal
20 sounds. Furthermore, it is hard to produce such esophageal sounds. For this reason, it is impossible for even patients, who have an ability to produce esophageal sounds, to speak for a lengthy period of time.

In order to solve such problems, an articulation method using an electronic artificial larynx has recently
25 been proposed.

Conventional electronic artificial larynx devices are mainly classified into those of an external type and an internal type. The external type larynx devices are also classified into a mouth type and a neck type.

30 In mouth type larynx devices, a small-diameter tube connected to a vibrator is inserted in the oral cavity to produce a sound. In such mouth type larynx devices,

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however, it is difficult to control the pitch and intensity of sound. The tube inserted in the oral cavity may interfere with an articulation of the produced sound into words.

5 In neck type larynx devices, a vibrating appliance is used in a state in which it is in contact with the neck. In this case, a patient using such a neck type larynx device produces no sound, but moves his mouth as if were saying words. When the patient moves his mouth,
10 vibrations generated from the vibrating appliance are resonated. As a result, a sound articulated into words is emitted through the oral cavity and mouth. Such neck type larynx devices are widely used in that they have no interference with an articulation of the produced sound
15 into words and are convenient in use as compared to the mouth type larynx devices.

Most of known neck type electronic artificial larynx devices have a basic configuration including an oscillating signal output unit for generating frequency
20 and pulse signals, an amplifier for amplifying the pulse signal output from the oscillating signal output unit and a vibrating appliance for generating vibrations in response to the output signal from the amplifier and vibrating the user's neck by the generated vibrations,
25 thereby causing the vibrations to be resonated in accordance with the shape of the user's mouth and to be emitted through the user's neck and oral cavity in the form of a sound articulated into words. In addition, the oscillating signal output unit includes a frequency and
30 pulse width modulation means for modulating the frequency and pulse width of the frequency and pulse signals in accordance with the characteristics of the vibrating

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appliance. The modulation of the frequency and pulse width modulation means is carried out based on a variable time constant.

5 In such neck type artificial larynx devices, the frequency and pulse width modulation means included in the oscillating signal output unit serves to match the vibration state of the vibrating appliance with an appropriate vibration range depending on the user. The frequency and pulse width modulation means includes a pair
10 of modulation means respectively installed at the frequency oscillator end associated with the pitch of sound and the pulse oscillator end associated with the intensity of sound.

As the frequency and pulse width modulation means
15 modulates the frequency and pulse width of the output signals from the oscillating signal output unit, the vibration state of the vibrating appliance is eventually varied. Thus, the pitch and intensity of the sound
finally output can be adjusted.

20 The frequency and pulse width modulation means included in the oscillating signal output unit includes a pair of time constant circuits respectively installed at the frequency oscillator circuit end and the pulse oscillator circuit end. Each of the time constant
25 circuits comprises a resistor element.

The time constant circuits serve to modulate the oscillating frequency of the frequency oscillator and the pulse width of the pulse oscillator in accordance with the resistances of their resistor elements, respectively. In
30 most recent neck type artificial larynx devices, variable resistors such as semi-fixed resistors or slide resistors are used.

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In a neck type artificial larynx device using variable resistors, such as semi-fixed resistors or slide resistors, for the frequency and pulse width modulation means of its oscillating signal output unit, it is possible to vary the frequency and pulse width of the output signals from the oscillating signal output unit by varying the resistances of the variable resistors to desired values, respectively. Consequently, it is possible to adjust the pitch and intensity of a sound articulated into words. Although the resistance variation of those resistors can be easily conducted in the manufacture process by the manufacturer, it is difficult for the user to conduct such a resistance variation during his speaking conducted using the artificial larynx device. Ultimately, it is difficult for the user to optionally control the pitch and intensity of a sound articulated into words during his speaking.

In some artificial larynx devices using slide resistors for the variable resistors of the time constant circuits, a configuration is used in which a control knob is coupled to each of the slide resistors in such a fashion that it is outwardly exposed from a larynx device body, thereby enabling the resistance of each slide resistance to be adjusted by a rotation of the associated knob. In this configuration, however, it is difficult to expect a rapid and accurate variation in the pitch and intensity of a sound articulated into words when the user rotates the control knob during his speaking. As a result, there is a problem in that it is impossible to produce articulated sounds equivalent to natural vocal sounds.

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Disclosure of the Invention

Therefore, an object of the invention is to solve the above mentioned problems involved in the prior art, and to provide a neck type artificial larynx device having improved characteristics enabling a laryngectomized patient to easily and optionally control the pitch and intensity of a sound articulated into words while the patient speaks using the artificial larynx device.

In accordance with the present invention, this object is accomplished by providing a neck type artificial larynx device including an oscillating signal output unit having a frequency oscillator and a pulse oscillator respectively provided with time constant circuits each serving as modulation means and having a time constant variable depending on a variation in resistance, an amplifier for amplifying a pulse signal output from the oscillating signal output unit, and a vibrating appliance for generating vibrations in response to an output signal from the amplifier and vibrating a user's neck by the generated vibrations, thereby causing the vibrations to be resonated in accordance with a shape of a user's mouth and to be emitted through the user's neck and oral cavity in the form of a sound articulated into words, wherein: said modulation means provided at said frequency oscillator comprises first depressing means installed on an outer surface of a body of said artificial larynx device, and a first pressure sensor consisting of a resistor element varying in resistance by a depressing operation of said first depressing means; and said modulation means provided at said pulse oscillator comprises second depressing means installed on an outer surface of said device body opposite to said modulation means associated with said frequency

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oscillator, and a second pressure sensor consisting of a resistor element varying in resistance by a depressing operation of said second depressing means.

5 In accordance with the present invention, the resistances of the first and second pressure sensors vary optionally in response to the pressures applied by the first and second depressing means. The first and second depressing means may be installed on the outer surface of the device body in such a fashion that the user can
10 depress the first and second depressing means by the thumb and index finger while grasping the device body. Accordingly, it is possible for the user to modulate the frequency of the frequency oscillator and the pulse width of the pulse oscillator during speaking. Ultimately, it
15 is possible to vary the vibrating characteristics of the vibrating plate included in the vibrating appliance, thereby varying the pitch and intensity of articulated speech.

20 In accordance with a preferred embodiment of the present invention, the first and second depressing means are combined with power switching means.

For example, each of said first and second depressing means comprises a power switch provided at one end thereof with a push knob and at the other end thereof with a
25 depressing rod adapted to reciprocally slide in accordance with a depressing operation of said push knob, thereby switching on and off said power switch.

When the push knob is depressed by a certain pressure, the depressing rod comes into contact with the
30 surface of the pressure sensor, thereby causing the power switch to be primarily switched on in order to supply a drive voltage. In this state, the power switch serves as

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a power switching means. As the push knob is further depressed, the depressing rod depresses the surface of the pressure sensor, thereby varying the resistance of the pressure sensor in accordance with the depressing pressure. In this case, the power switch serves as a resistance varying means. Accordingly, there is convenience in the use of the artificial larynx device.

Brief Description of the Drawings

Other objects and aspects of the invention will become apparent from the following description of embodiments with reference to the accompanying drawings in which:

Fig. 1 is a perspective view illustrating the appearance of an artificial larynx device according to an embodiment of the present invention;

Fig. 2 is a circuit diagram of the artificial larynx device according to the embodiment of the present invention; and

Fig. 3 is an enlarged cross sectional view taken along the line 3 - 3 of Fig. 1, illustrating an installed configuration of pressure sensors and power switches included in the artificial larynx device of Fig. 1.

Best Mode for Carrying Out the Invention

Referring to Figs. 1 to 3, an artificial larynx device according to an embodiment of the present invention is illustrated.

As shown in Fig. 1, the artificial larynx device, which is denoted by the reference numeral 10, includes a device body 11. A cap 13 is mounted to the upper end of the device body 11.

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A vibrator 25 to be described hereinafter is mounted in the interior of the cap 13. The vibrator 25 includes a vibrating plate 15 outwardly exposed at an opened upper end of the cap 13 and adapted to come into contact with the neck of the user.

A pair of push knobs 17 and 17a are slidably fitted in through holes radially perforated through the device body 11 at opposite sides of the device body 11, respectively. The push knobs 17 and 17a are arranged at positions where the user conveniently depresses those push knobs by the thumb and index finger, respectively. The push knobs 17 and 17a are slightly protruded from the outer side surface of the device body 11 and are radially slidable by a certain distance. These push knobs 17 and 17a serve to switch on and off power switches 29 and 29a, respectively.

Fig. 2 is a circuit diagram of the artificial larynx device 10 according to the illustrated embodiment of the present invention.

In Fig. 2, the reference numeral 21 denotes an oscillating signal output unit. The oscillating signal output unit 21 includes a frequency oscillator 211, a first time constant circuit 213, a second time constant circuit 217, and a monostable multivibrator 215.

The first time constant circuit 213 includes a resistor R21, a first pressure sensor FSR1, and a capacitor C21. The first time constant circuit 213 serves to modulate the oscillation frequency of the frequency oscillator 211 in accordance with the resistance of the first pressure sensor FSR1.

The monostable multivibrator 215 is triggered in response to an oscillating signal output from the

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frequency oscillator 211, thereby generating a pulse signal with a certain pulse width.

The second time constant circuit 215 includes a second pressure sensor FSR2, and a capacitor C23. The
5 second time constant circuit 215 serves to vary the pulse width of the pulse signal output from the monostable multivibrator 215 in accordance with the resistance of the second pressure sensor FSR2.

The time constant of the second time constant circuit
10 217 is set so that the pulse width of the pulse signal output from the monostable multivibrator 215 being triggered is much shorter than one period of the pulse signal output from the frequency oscillator 22.

In Fig. 2, the reference numeral 23 denotes an
15 amplifier for amplifying the oscillating signal output from the oscillating signal output unit 21. The reference numeral 25 denotes a vibrator for vibrating the vibrating plate 15 in response to the oscillating signal amplified by the amplifier 23. The reference numeral 27 denotes a
20 power supply for supplying a drive voltage.

Fig. 3 is an enlarged cross sectional view taken along the line 3 - 3 of Fig. 1. Fig. 3 illustrates an installed configuration of the first pressure sensor FSR1, second pressure sensor FSR2, power switches 29 and 29a,
25 and push knobs 17 and 17a.

As shown in Fig. 3, the push knobs 17 and 17a of the power switches 29 and 29a are slightly protruded from the outer side surface of the device body 11 in opposite radial directions at opposite sides of the device body 11.
30 These push knobs 17 and 17a are radially slidable into the interior of the device body 11 by a certain distance.

The power switches 29 and 29a are also provided with

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depressing rods 291 and 291a radially protruded from the inner ends of the power switches 29 and 29a into the interior of the device body 11, respectively. The depressing rods 291 and 291a extend in perpendicular to the first and second pressure sensors FSR1 and FSR2 vertically arranged in the interior of the device body 11, respectively. In a normal state of the push knobs 18 and 18a not depressed, the inner ends of the depressing rods 291 and 291a are slightly radially spaced from the first and second pressure sensors FSR1 and FSR2, respectively. The power switches 29 and 29a along with their depressing rods 291 and 291a slide radially inwardly toward the first and second pressure sensors FSR1 and FSR2 when the push knobs 18 and 18a are depressed, respectively.

When the user depresses the push knobs 17 and 17a of the power switches 29 and 29a, the power switches 29 and 29a are moved inwardly into the interior of the device body 11, thereby causing the depressing rods 291 and 291a to come into contact with the central pressure surfaces of the first and second pressure sensors FSR1 and FSR2, respectively.

When the depressing rods 291 and 291a come into contact with the central pressure surfaces of the first and second pressure sensors FSR1 and FSR2, the power switches 29 and 29a are switched to their ON states. At the ON states of the power switches 29 and 29a, the drive voltage from the power supply 27 is supplied to the oscillating signal output unit 21 and amplifier 23.

When the user further depresses the push knobs 17 and 17a in the ON states of the power switches 29 and 29a, the central pressure surfaces of the first and second pressure sensors FSR1 and FSR2 are further depressed, thereby

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causing the resistances of those sensors to increase. At this time, of course, the power switches 29 and 29a are maintained in their ON states.

Where a laryngectomized patient, who loses laryngeal functions due to removal of the larynx, uses the above mentioned artificial larynx device 10 according to the illustrated embodiment of the present invention for speaking, he grasps the device body 11 by one hand, and then depresses the push knobs 17 and 17a by the thumb and index finger of the hand in a state in which the vibrating plate 15 arranged at the upper end of the cap 13 is in contact with the neck.

When the user depresses the push knob 17 and 17a by a desired pressure, the power switches 29 and 29a are moved into the interior of the device body 11, thereby causing the depressing rods 291 and 291a to come into contact with the first and second pressure sensors FSR1 and FSR2, respectively. As a result, the power switches 29 and 29a are switched to their ON states. At the ON states of the power switches 29 and 29a, the drive voltage from the power supply 27 is supplied to the oscillating signal output unit 21 and amplifier 23. Accordingly, the artificial larynx device 10 is switched to its normal operation state.

In the normal operation state of the artificial larynx device 10, the frequency oscillator 211 of the oscillating signal output unit 21 oscillates in accordance with the time constant of the first time constant circuit 213, thereby outputting an oscillating signal. The oscillating signal output from the frequency oscillator 211 is applied to the monostable multivibrator 215 as a trigger signal. In response to the trigger signal, the

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monostable multivibrator 215 outputs a pulse signal with a pulse width determined in accordance with the time constant of the second time constant circuit 217.

5 The pulse signal output from the monostable multivibrator 215 of the oscillating signal output unit 21 is then amplified to a sufficient level by the amplifier 23. The resultant signal is then applied to the vibrator 25.

10 In response to the pulse signal, the vibrator 25 vibrates its vibrating plate 15, thereby vibrating the user's neck. When the user moves his mouth as if were saying words, vibrations transmitted from the vibrating plate 15 to the neck are resonated in accordance with the shape of the mouth. As a result, a sound articulated into
15 words is emitted through the oral cavity and mouth. Thus, the user can say words.

When the user maintains the pressures respectively applied to the push knobs 17 and 17a in the normal operation state of the artificial larynx device 10, the
20 pressures respectively applied to the central pressure surfaces of the first and second pressure sensors FSR1 and FSR2 by the depressing rods 291 and 291a are still maintained. In this state, the time constants of the first and second time constant circuits 213 and 215 are
25 still maintained.

Accordingly, the signal generated from the frequency oscillator 211 in response to the time constant from the first time constant circuit 213 is constant in frequency. Also, the pulse signal generated from the monostable
30 multivibrator 215 in response to the time constant from the second time constant circuit 215 is constant in pulse width. As a result, the resonated sound emitted from the

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user's mouth is constant in pitch and intensity.

Where it is desired to adjust the pitch of an articulated sound in the normal operation state of the artificial larynx device 10, the user varies the pressure applied to one of the push knob 17 associated with the first pressure sensor FSR1.

In accordance with the variation in the pressure of the one-end push knob 17 applied to the first pressure sensor FSR1, the resistance of the first pressure sensor FSR1 is varied, thereby varying the time constant of the first time constant circuit 213. This results in a modulation in the oscillation frequency of the frequency oscillator 211. As a result, the pulse signal output from the monostable multivibrator 215 is modulated in frequency. This results in a modulation in the vibration frequency of the vibrating plate 15 included in the vibrator 25. Accordingly, the articulated sound emitted through the user's neck and mouth varies in pitch.

When the oscillation frequency range of the frequency oscillator 211 modulated in accordance with a variation in the resistance of the first pressure sensor FSR1 corresponds to a frequency range of about 70Hz to about 140Hz, the most excellent effect is obtained.

On the other hand, where it is desired to adjust the intensity of an articulated sound in the normal operation state of the artificial larynx device 10, the user varies the pressure applied to the other push knob 17a associated with the second pressure sensor FSR2.

In accordance with the variation in the pressure of the other push knob 17a applied to the second pressure sensor FSR2, the resistance of the second pressure sensor FSR2 is varied, thereby varying the time constant of the

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second time constant circuit 217. This results in a modulation in the pulse width of the pulse signal output from the monostable multivibrator 215. As a result, the vibration intensity of the vibrating plate 15 included in the vibrator 25 varies. Accordingly, the articulated sound emitted through the user's neck and mouth varies in intensity.

When the pulse width range of the monostable multivibrator 215 modulated in accordance with a variation in the resistance of the second pressure sensor FSR2 corresponds to a range of about 0.5msec to about 2.5msec, the most excellent effect is obtained.

Industrial Applicability

As apparent from the above description, the electronic artificial larynx device of the present invention can easily adjust the pitch and intensity of an articulated sound by controlling respective pressures applied by the push knobs installed on the outer surface of the device body, as compared to conventional neck type artificial larynx devices including a configuration adapted to selectively adjust the pitch and intensity of an articulated sound prior to the use of the device or another configuration using a slidable or rotatable knob type resistor to adjust the pitch and intensity of an articulated sound during speaking. In accordance with the present invention, therefore, it is possible to achieve a great improvement in the quality and distinction of articulated speech. Accordingly, there is an advantage in that articulated sounds equivalent to natural vocal sounds is produced.

Although the preferred embodiments of the invention

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have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

For instance, although the power switches have been described as being arranged at opposite sides on the outer surface of the device body in such a fashion that they are laterally symmetric with each other, they may be installed at any positions where the user conveniently depresses those power switches by the thumb and index finger, respectively, while grasping the device body.

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Claims

1. A neck type artificial larynx device including an oscillating signal output unit having a frequency oscillator and a pulse oscillator respectively provided
5 with time constant circuits each serving as modulation means and having a time constant variable depending on a variation in resistance, an amplifier for amplifying a pulse signal output from the oscillating signal output unit, and a vibrating appliance for generating vibrations
10 in response to an output signal from the amplifier and vibrating a user's neck by the generated vibrations, thereby causing the vibrations to be resonated in accordance with a shape of a user's mouth and to be emitted through the user's neck and oral cavity in the
15 form of a sound articulated into words, wherein:

said modulation means provided at said frequency oscillator comprises first depressing means installed on an outer surface of a body of said artificial larynx
20 device, and a first pressure sensor consisting of a resistor element varying in resistance by a depressing operation of said first depressing means; and

said modulation means provided at said pulse oscillator comprises second depressing means installed on an outer surface of said device body opposite to said
25 modulation means associated with said frequency oscillator, and a second pressure sensor consisting of a resistor element varying in resistance by a depressing operation of said second depressing means.

2. The neck type artificial larynx device in
30 accordance with Claim 1, wherein each of said first and second depressing means comprises a power switch provided

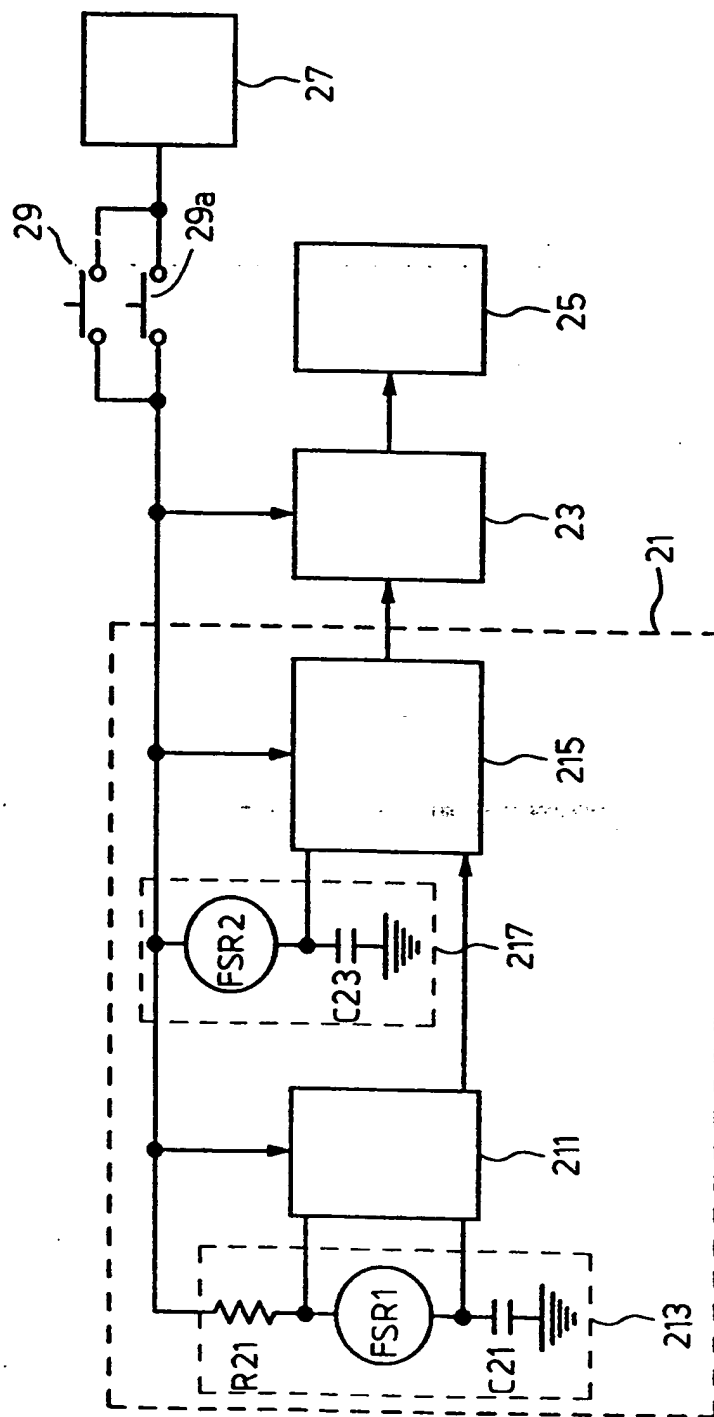
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at one end thereof with a push knob and at the other end thereof with a depressing rod adapted to reciprocally slide in accordance with a depressing operation of said push knob, thereby switching on and off said power switch.

- 5 3. The neck type artificial larynx device in accordance with Claim 1, wherein said first and second pressure sensors have facing central pressure surfaces arranged in the interior of said device body in such a fashion that they extend along an axis of said device
10 body, and said first and second depressing means are slidable in a direction perpendicular to said central pressure surfaces of said first and second pressure sensors so that they selectively come into contact with said central pressure surfaces, respectively.

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FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 99/00180

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁶: A 61 F 2/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC⁶: A 61 F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 272 647 A (VEIT et al.) 09 June 1981 (09.06.81), abstract; fig.1,2.	1
A	US 5 326 343 A (BARAFF) 05 July 1994 (05.07.94), abstract; fig.2-5.	1
A	WO 86/06 271 A (DACOMED), 06 November 1986 (06.11.86), abstract; fig.1.	1
A	US 4 338 488 A (LENNOX), 06 July 1982 (06.07.82), claim 1; fig.1.	1
A	US 4 627 095 (THOMPSON), 02 December 1986 (02.12.86), abstract; fig.1.	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

07 June 1999 (07.06.99)

Date of mailing of the international search report

23 July 1999 (23.07.99)

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INTERNATIONAL SEARCH REPORT
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International application No. PCT/KR 99/00180

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